

The Butterflies of Isla de Cedros, Baja California Norte, Mexico

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Abstract. Isla de Cedros is an arid Pacific island off the western coast of Baja California Norte, Mexico. The island supports a depauperate butterfly fauna consistent with other offshore islands which exhibit varying degrees of faunal reduction when compared to their mainland counterparts. The 23 butterfly species recorded from Isla de Cedros reflect 2 broad categories of presumptive biogeographic origin: 1) species of Neotropical origin, which are distributed throughout the peninsula; and 2) species of Nearctic origin, some of which occur throughout the peninsula, and others confined to the Californian province of the adjacent peninsula. The 80 year history of entomological activity on the island is outlined; the physiography of the area is briefly discussed; and the 23 butterfly species are listed with capture records and taxonomic comments. Additionally, an endemic species, *Mitoura cedrosensis* is described and illustrated.

Introduction

The butterfly fauna of Isla de Cedros, Baja California Norte, Mexico, has been sampled on numerous occasions over the past 80 years, most recently by the authors in 1981 and 1983. A total of 23 butterfly species has been recorded from the island, including 1 endemic species and 1 endemic subspecies. This number is considerably less than the number of species that would be found in comparable habitats on the adjacent mainland. This fact is consistent with other offshore islands which exhibit varying degrees of faunal reduction, generally dependent upon their size and distance from continental masses (MacArthur and Wilson, 1967; Pielou, 1979; Langston, 1980). Geologic evidence of a previous landbridge to the peninsula of Baja California suggests the past opportunity for the development of a more diverse fauna than is currently evident. Pielou (1979) suggests that upon separation from the mainland, continental islands have an over-saturated biota, and that a period of floral and faunal reduction ensues until the number of species on the island falls to an appropriate equilibrium level. Clear evidence of faunal reduction has been given by Wilcox (1978) for the lizard faunas of several Baja California islands. In the butterfly fauna of Cedros,

however, the island appears to be in an under-saturated (non-equilibrium) condition.

The peninsula of Baja California can be divided into 3 major biotic provinces: a northwestern Californian region, a central desert region, and a southern subtropical thorn scrub region which includes the cape. Floral characteristics of the northwestern province occur as disjuncts southward on scattered higher peaks forming outposts of this region as far south as the mountains of the cape. Such an outpost occurs in the higher elevations of Isla de Cedros. Before the origin of the deserts in the late Quaternary, these southern relicts were presumably more nearly continuous with the northwestern region (Gould and Moran, 1981). As a consequence of this outpost effect, several Californian elements reach their southern limit on Isla de Cedros, considerably disjunct and isolated from the southern end of their contiguous peninsular populations to the north.

Collecting History

Although seldom a primary destination, Isla de Cedros has historically provided a stop-over for boat expeditions traveling along the Pacific coast of Baja California. The following outline briefly summarizes the historical accounts of entomological activity on the island.

- 1905. California Academy of Sciences Expedition to the Galapagos Islands. On Cedros 18 July 1905. F.X. Williams, entomologist.
- 1922. California Academy of Sciences Expedition to the Eastern Pacific Islands. On Cedros 22 July 1922. G. Hanna and J. Slevin, collectors.
- 1925. California Academy of Sciences Expedition to Revillagigedo Islands. On Cedros 2-6 June 1925. H. H. Keifer, entomologist.
- 1932. Allan Hancock Pacific Expedition. On Cedros 25 February 1932. J. S. Garth, entomologist.
- 1934. Allan Hancock Pacific Expedition. On Cedros 10 March 1934. J. S. Garth, entomologist.
- 1937. Allan Hancock Pacific Expedition. On Cedros 10 and 12 July 1937. J. S. Garth, entomologist.
- 1937-1939. Several boat trips to Baja California by F. Rindge family. F. H. Rindge, entomologist.
- 1941. Allan Hancock Pacific Expedition. On Cedros 28 February 1941. J. S. Garth, entomologist.
- 1949. Velero IV Gulf of California Cruise. On Cedros 4-5 March 1949. J. S. Garth, entomologist.
- 1981. San Diego Natural History Museum Expedition to Northern Baja California. On Cedros 20-23 March 1981. D. Faulkner and F. Andrews, entomologists.
- 1983. San Diego Natural History Museum Expedition to Isla de Cedros. On Cedros 28 March-5 April 1983. J. Brown and D. Faulkner, entomologists.

1983. Diamaresa Expedition to Pacific Islands Adjacent to Baja California. On Cedros 30 June-2 July 1983, 13 July 1983. D. Faulkner, D. Weissman, D. Lightfoot, and V. Lee, entomologists.

Although there have been a number of visits to the island in the past 80 years, few of the expeditions spent more than a brief time on the island, making only short trips into the more accessible localities, such as Cañon de la Mina in the north. This is reflected in the few Lepidoptera specimens available for examination as well as the low number of species recorded until recently.

Physiography

Geology. Isla de Cedros is a rather large (348 km²), rugged, mountainous island (Fig. 1) situated about midway down the western side of the peninsula of Baja California, Mexico (Fig. 2). Oriented north to south, the island is about 34 km in length and varies from about 4 to 15 km in width. The southeastern extremity, Punta Morro Redondo, is separated from the mainland by a narrow and shallow strait 22 km wide. Projecting northwest from the mainland, Punta San Eugenio represents the southern connection of a presumed landbridge that once united Cedros with the peninsula (Gentry, 1950). It is likely that migrant species regularly reach Cedros by "island hopping" from Punta San Eugenio to Isla Natividad, and from there to Cedros.

The island's montane spine is bisected into a northern and a southern range by a deep gorge called El Gran Cañon or El Arroyo Grande. The highest point, Cerro de Cedros, in the southern half of the island,



Fig. 1. Eastern coast of Isla de Cedros, looking south from Punta Norte.

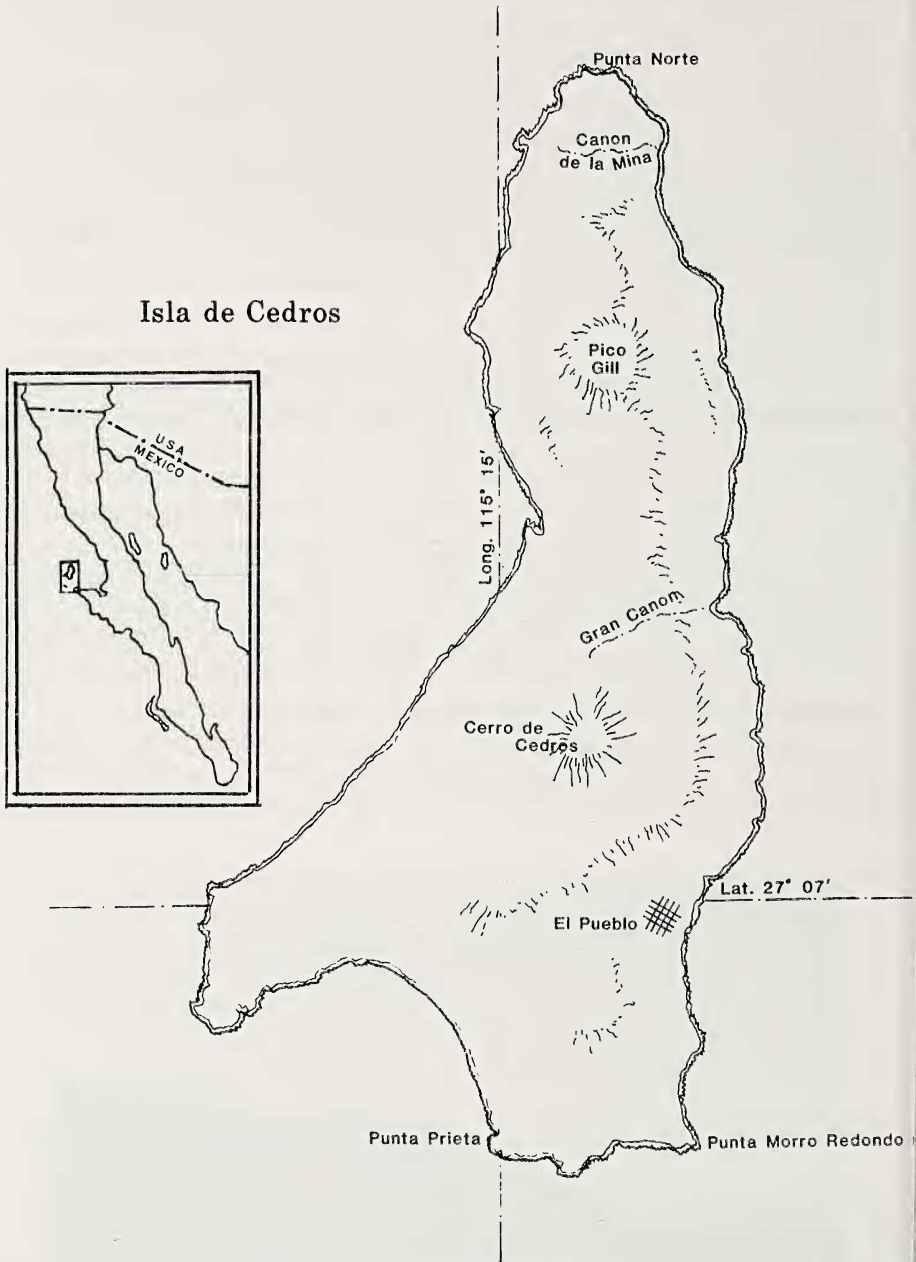


Fig. 2. Map of Isla de Cedros; all localities mentioned in the text are figured.

reaches an elevation of 1200 m (3950'). The uplifted sedimentary strata reflect a history of tremendous geologic disturbances. The granodioritic rocks present are of pre-Cretaceous and Pliocene origin (Wiggins, 1980).

A reconnaissance of the geology of Isla de Cedros (Kilmer, 1977) indicates that the island was formed by an uplift of late Jurassic metamorphic and igneous rock at a point where the Pacific plate was subducted beneath the western margin of the North American plate. The possible geological relationship of Isla de Cedros with the California Channel Islands emphasizes the relationship between the small but striking relictual floral elements common to the two areas (Moran and Benedict, 1981).

Climate. The climate of Isla de Cedros is generally temperate owing to its proximity to Mediterranean climatic regimes; however, long, hot, dry spells are common. Cedros is near the southern edge of California's winter Pacific storm tract, and at the northern extreme of southern Baja California's tropical summer storm pattern. Precipitation records, as a result, indicate extreme inconsistency in both seasons; in some years little or no rain reaches the island. Figure 3 provides climatological data adapted from Hastings and Humphrey (1969).

In the vicinity of Isla de Cedros, generally to the north and west, there are often low, dense mists or fog banks which are common in all seasons but particularly in the summer months (Libby, Bannister, and Linhart, 1968; Lewis and Ebeling, 1971). The abundant moisture provided by this condition has great influence in producing the luxuriant desert vegetation which occurs during certain seasons on parts of the western slopes (Nelson, 1921), and sustains the stands of Monterey pine that occur on the west and northwest escarpments of the island's northern range.

Flora

Because of its accessibility by ship, and more recently by cargo plane, the flora of Isla de Cedros has been rather extensively studied (Moran, 1972). Hale (1941) estimates that 97% of the island is covered by desert scrub vegetation similar to that occurring throughout the Vizcaino-Magdalena region of the adjacent peninsula. The most striking and conspicuous plants occurring over most of the island are the elephant tree (*Pachycormus discolor* (Benth.) Cov.) and the mescál (*Agave sebastiana* (Greene) Gentry) (Fig. 4). In small isolated areas the desert scrub gives way to other types of vegetation, most notably coastal sage scrub, chaparral, and even coniferous forest. The most remarkable departure from the desert vegetation is the closed-cone pine forests dominated by *Pinus radiata* var. *cedrosensis* J. T. Howell which occur in 2 major populations in the mountains (Libby, Bannister, and Linhart, 1968). Several Californian floral elements reach their southern limit on

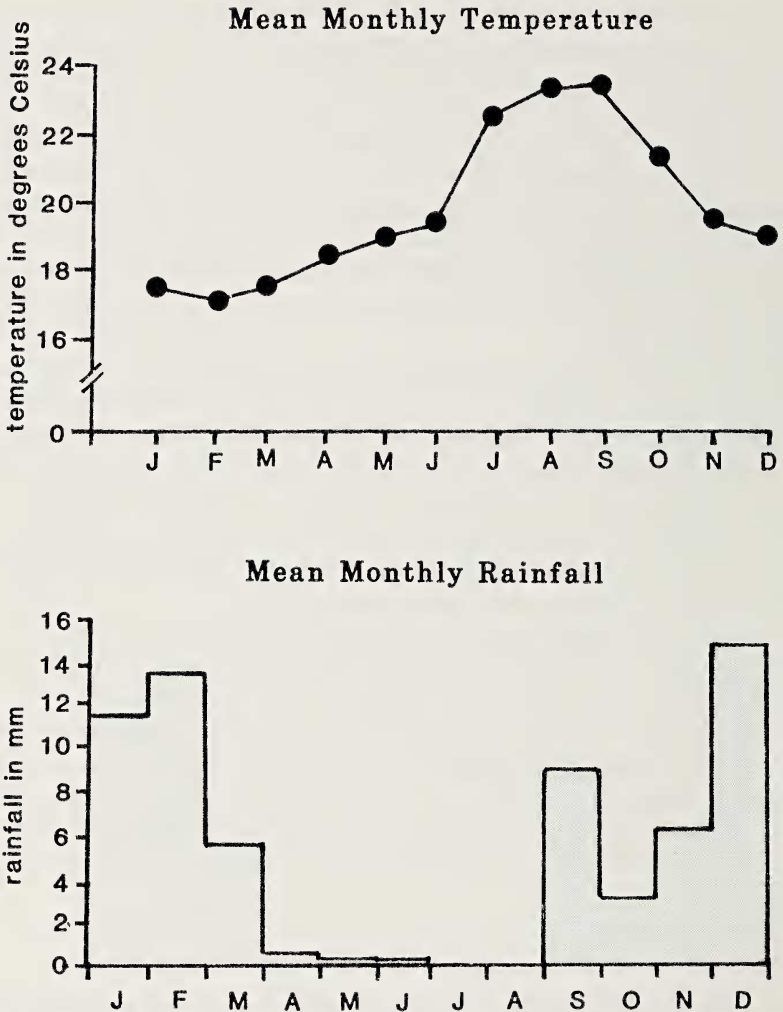


Fig. 3. Climatological data adapted from Hastings and Humphrey (1969). **Above:** Annual precipitation (in mm). **Below:** Average annual temperature (in °C).

Cedros including California juniper (*Juniperus californica* Carr.), lemonade berry (*Rhus integrifolia* (Nutt.) Rothr.), chamise (*Adenostoma fasciculatum* var. *obtusidolium* S. Wats.), and California sage brush (*Artemisia californica* Less.). The flora of the island includes 245 vascular plants, of which 216 species are native and 29 species introduced (Moran and Benedict, 1981). Of the native flora, 16 species are endemic to Isla de Cedros and are discussed by Moran (1972).

Butterfly Fauna

The 23 butterfly species recorded from Isla de Cedros represent 6 families: HesperIIDae (2 species), Pieridae (7 species), Lycaenidae (9



Fig. 4. **Above:** Fog-enshrouded Canon de la Mina at the north end of the island. The tall, white-flowered, endemic *Eriogonum molle* is conspicuously abundant. **Below:** Characteristic vegetation near the light-house at Punta Norte, dominated by *Agave sebastiana* and *Opuntia* species.

species), Riodinidae (2 species), Nymphalidae (2 species), and Danaidae (1 species). The 23 species reflect 2 extremely broad categories of biogeographic origin: the Neotropical and the Nearctic.

Species of Neotropical origin represented in the island's fauna are widespread forms that occur the entire length of the peninsula, extending more or less from South or Central America northward into southern California. Species in this category include *Erynnis funeralis*, *Phoebis sennae*, *Eurema nicippe*, *Strymon columella*, *Brephidium exilis*, *Leptotes marina*, *Hemiargus ceraunus*, and *Danaus gilippus*. These species represent approximately 35% of the total butterfly fauna.

Elements of Nearctic origin illustrate 2 patterns of mainland distribution: a) species distributed throughout the peninsula, including *Pyrgus albescens*, *Pieris protodice*, *Colias eurytheme*, *Strymon melinus*, *Celastrina Iadon*, *Apodemia mormo*, *Calephelis wrighti*, *Vanessa cardui*, and *Vanessa annabella*, comprising approximately 39% of the butterfly fauna; and b) species typically confined to the Californian province of the adjacent peninsula, represented on Cedros by disjuncts or isolated relict populations, including *Pieris beckerii*, *Anthocharis sara*, *Anthocharis cethura*, *Mitoura cedrosensis* new species, *Philotes sonorensis*, and *Euphilotes battoides*. All of these Californian elements reach their southernmost distributional limits on Cedros. Included in this group are the 2 endemic taxa. The Californian province elements account for approximately 26% of the species recorded from the island. Thus were it not for a broad zone of distributional overlap between the widespread Neotropical and widespread Nearctic species, the island's fauna would most likely reflect an even more depauperate condition than is currently illustrated.

Approximately 50% of the species known from the adjacent mainland (species pool) occur on Isla de Cedros. This is consistent with the finding of Langston (1980) regarding the faunal composition of Santa Cruz Island which is located off the western coast of California. The two islands share 9 species of butterflies representing widespread Neotropical, widespread Nearctic, and Californian province elements. The species in common all exhibit a high degree of vagility.

Latitude seems to have little effect on the phenology of the Californian elements. Although Isla de Cedros is 500 km (310 mi) south of the California-Baja California border, species' flight periods closely resemble those of their southern California counterparts. Several of the univoltine species do, however, exhibit extended flight periods giving the appearance of more than a single brood, i.e., *Philotes sonorensis* and *Euphilotes battoides*. Langston (1975) has shown that species occurring near the Pacific coast (of California) often display this tendency, probably in response to mild winters, periods of inclement spring weather, and moderate summer temperatures, which in turn contribute to the staggered development of the various larval hostplants.

We examined 457 specimens representing 23 species. An additional 2 species, *Danaus plexippus* (L.) and a large dark papilionid, both reported as sight records by David Weissman, are mentioned here but are not included in the species accounts. All observations were made by the authors during 1981 and 1983.

Unless otherwise indicated, all specimens listed in the species accounts were collected by Faulkner and Brown, and are deposited in the San Diego Natural History Museum. Specimens collected by J. Garth are in the collection of the Allan Hancock Foundation at the University of Southern California, Los Angeles. Additional depositories are abbreviated as follows: CAS, California Academy of Sciences, San Francisco; and LACM, Los Angeles County Museum of Natural History.

Species Accounts

HESPERIIDAE

1. *Erynnis funeralis* (Scudder and Burgess).

First reported from Cedros by Rindge (1948), we collected *E. funeralis* on both the north and south ends of the island. It was encountered more often at mid-to-low elevations, frequently "patrolling" canyons. Several species of *Lotus* (Fabaceae) occur on the island, and one or more of these probably serve as larval hosts. *E. funeralis* occurs the entire length of the peninsula of Baja California, and there appear to be no phenotypic differences between mainland and insular populations.

MacNeill (1975) indicates that *funeralis* has considerable dispersal ability and has been shown to be a pioneer species in several insular situations.

Specimens examined: Punta Norte, 30 March 1983 (2 males), 1 April 1983 (2 males); vicinity El Pueblo, 4 April 1983 (1 female).

2. *Pyrgus albescens* Plötz

MacNeill (1975) states that *P. albescens* and *P. communis* (Grote) are ecologically isolated as well as (genetically) distinct. On this basis, they appear to represent separate species and were treated as such by Miller and Brown (1981). That treatment is followed here.

P. albescens is a widespread inhabitant of the hot, arid lowlands of the southwestern United States and adjacent Mexico. It was one of the more common butterflies encountered on Cedros in both spring and summer of 1983. It was particularly abundant in disturbed areas in the vicinity of El Pueblo, especially in association with the weedy, introduced *Malva parviflora* L. (Malvaceae). Several specimens were also collected on the south slope of Cerro de Cedros, near the summit, in association with *Sphaeralcea fulva* Greene (Malvaceae). No phenotypic differences are apparent between peninsular and insular populations.

Specimens examined: El Pueblo, 29 March 1983 (1 male), 4 April 1983

(10 males), 13 July 1983 (2 males); Punta Norte, 31 March 1983 (1 female), 1 April 1983 (1 male, 1 female), 3 July 1983 (2 males); vicinity Cerro de Cedros, 3 April 1983 (4 males, 1 female), 1 July 1983 (2 males); Gran Cañon, 2 July 1983 (1 male).

PIERIDAE

3. *Pontia protodice* Boisduval and LeConte

As *P. protodice* occurs commonly throughout much of the United States and northern Mexico, and in a variety of habitats, it was not surprising to find this species on Isla de Cedros. Specimens were collected on both the north and south ends of the island. Some of the possible cruciferous hosts available include *Descurainia*, *Sisymbrium*, and *Thelypodium*. Although seasonally polyphenic, *P. protodice* is quite homogeneous in phenotype throughout its range (no subspecies), including Isla de Cedros.

Specimens examined: vicinity Punta Norte, 28 February 1941 (1 male), leg: J. Garth, 30 March 1983 (1 male), 1 April 1983 (1 male); vicinity El Pueblo, 3 April 1983 (1 female), 4 April 1983 (3 males).

4. *Pontia beckerii* Edwards

A common pierid of the western United States, *P. beckerii*, generally inhabits hot, shrubby, semi-arid habitats (Howe, 1975). Only in southern California and northwestern Baja California does it occur on or near the coast. The population on Cedros represents a slight southern disjunct from northern Baja California. The larval host, *Isomeris arborea* Nutt. (Capparidaceae), occurs commonly on the eastern side of the island (Hale, 1941); a single larva was collected on *I. arborea* in a disturbed area near El Pueblo. Specimens of *P. beckerii* from Cedros are indistinguishable from those of southern California.

Specimens examined: El Pueblo, 29 March 1983 (2 males), 3 April 1983 (1 male, 1 female), 4 April 1983 (1 female); Punta Norte, 1 April 1983 (1 female); vicinity Cerro de Cedros, 1 July 1983 (2 males).

5. *Anthocharis sara* Lucas

Widespread through the western United States, and extending south into northern Baja California, *A. sara* reaches its southernmost distribution on Isla de Cedros. Capture records from February through April may indicate two broods, as is the case in coastal southern California.

Although some insular populations from California are subspecifically distinct (Emmel and Emmel, 1973), specimens from Cedros appear to represent nominate *A. sara*. However, in about 10% of the male specimens, the black scaling at the posterior end of the bar located near the apical end of the DFW cell, extends basally forming a slight hook (Fig. 5). Although these individuals have a distinct appearance, this character is not consistent within the population sampled.

Specimens examined: vicinity Punta Norte, 25 February 1932 (2

males, 1 female), 28 February 1941 (1 male, 1 female), all *leg*: J. Garth, 30 March 1983 (10 males, 1 female), 31 March 1983 (3 males, 2 females), 1 April 1983 (7 males, 1 female), 2 April 1983 (5 males, 1 female); vicinity El Pueblo, 3 April 1983 (1 male).

6. *Anthocharis cethura* (Felder and Felder)

Restricted to the extreme southwestern United States and adjacent northern Mexico, *A. cethura* reaches its southernmost limit on Isla de Cedros. Although first collected on Cedros by John Garth in 1932, its occurrence there was not noted until Rindge's (1948) publication. In the spring of 1983 *A. cethura* was collected on both the north and south ends of the island. Although it was uncommon, generally observed singly in canyons or on hilltops, previous collectors have found it to be much more abundant. The authors collected a single larva on *Sibara pectinata* (Greene) Greene (Brassicaceae) which is widely distributed on Cedros. Other potential larval hosts available include *Thelypodium lasiophyllum* (Hook. and Arn.) and *Descurainia pinnata* (Walt.) (both Brassicaceae). Specimens from Cedros are probably best referred to nominate *A. cethura*.

Specimens examined: vicinity Punta Norte, 25 February 1932 (1 male), 28 February 1941 (12 males, 3 females), all *leg*: J. Garth, 31 March 1983 (1 male), 1 April 1983 (1 male), 2 April 1983 (1 male); vicinity El Pueblo, 29 March 1983 (1 male), 3 April 1983 (2 males).

7. *Colias eurytheme* Boisduval

This widespread species was encountered only sparingly on Cedros. Specimens were observed in spring and summer of 1983. The only example collected, however, was a damaged adult retrieved from a spider's web. Several legumes on the island are available as potential larval hostplants.

Specimen examined: vicinity Punta Norte, 3 July 1983 (1 female).

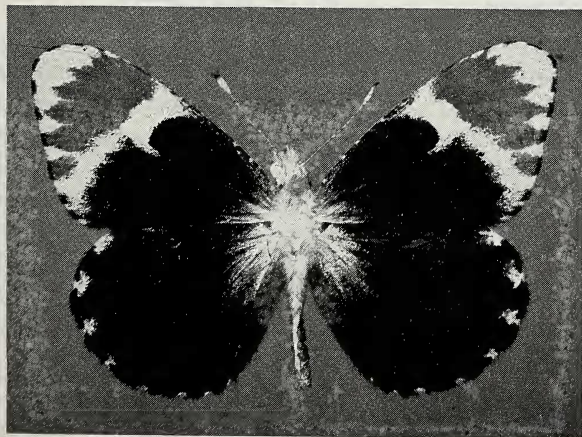


Fig. 5. *Anthocharis sara*, male, upper-surface, Isla de Cedros.

8. *Phoebis sennae marcellina* (Cramer)

Although probably not a breeding resident, *P. sennae* was commonly observed on both ends of the island in the summer of 1983. Captures were made in the late afternoon as the adults were settling on *Rhus*.

Larvae of *P. sennae* are known to feed on *Cassia* (Fabaceae), none of which are available on Cedros. A well-known disperser-migrator, *P. sennae* is frequently encountered far from its breeding areas, which appears to be the case on Isla de Cedros.

Specimens examined: vicinity Punta Norte, Cañon de la Mina, 3 July 1983 (2 males).

9. *Eurema nicippe* (Cramer)

E. nicippe is widespread throughout most of southern North America; it occurs the length of Baja California. As with the preceding species, *nicippe* does not appear to be a breeding resident on Cedros owing to the absence of *Cassia* as a larval host. It is possible that other legumes are utilized, but the flight-worn condition of specimens and their rapid unidirectional flight together seem to indicate that specimens taken on Cedros represent migrants from the adjacent mainland.

Specimens examined: vicinity Cerro de Cedros, 1 July 1983 (1 male); vicinity Punta Norte, Cañon de la Mina, 3 July 1983 (1 male).

LYCAENIDAE

10. *Mitoura cedrosensis* new species

Figures 6 and 7

Male: forewing length \bar{x} = 11.4 mm (range 11.0-12.0 mm; n = 14). Frons and vertex fuscous; eyes mesially edged with white; antennae black, white annulate, the club black with a fulvous tip. **Upperside:** both wings fuscous to mahogany brown with marginal, apical, and basal darkening. A thin terminal white bar on hindwing between tornus and Cu_2 . A short, thread-like tail at termination of Cu_2 of hindwing, black tipped with white. Only a small black tooth at Cu_1 , also tipped with white. Forewing scent patch well developed although variable in color. **Underside:** forewing rich mahogany brown with a fine postmedian line composed of 5 white dashes. Faint traces of maroon purple over-scaling apically, and faint basal darkening. Hindwing with a diffuse inconsistent maroon postbasal band; occasionally bordered at outer margin by a thin white line from M_3 toward costal margin, absent to very faint in some specimens. Terminal area aqua gray with a variable row of poorly defined black dots. In Cu_1 - Cu_2 a *Thecla* spot composed of 2 longitudinally arranged black dots divided by a poorly defined orange-brown lunule. Entire hindwing surface rather melanistic in appearance, with a faint iridescent luster.

Female: forewing length \bar{x} = 11.4 mm (range 11.0-12.0 mm; n = 9). **Upperside:** as in male but without scent patch, and color more consistent rich reddish brown; darkening confined to marginal area. **Underside:** as in male with little or no consistent differences.

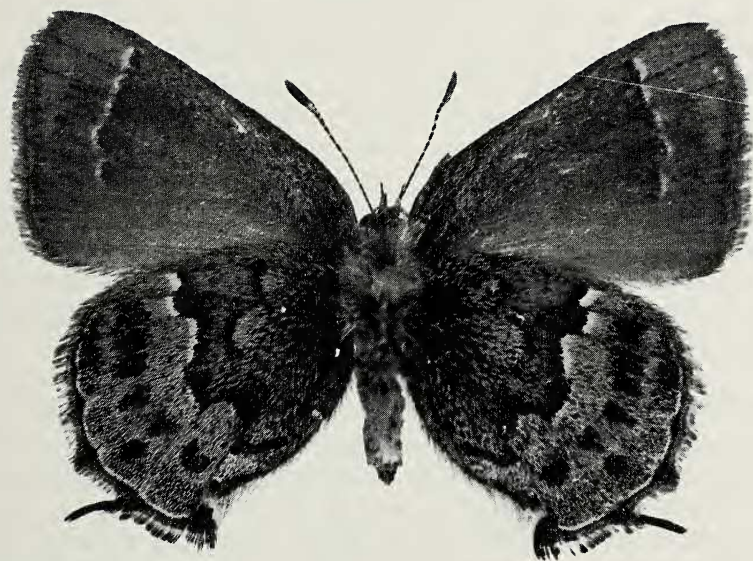


Fig. 6. *Mitoura cedrosensis*, female, uppersurface, Isla de Cedros.

Fig. 7. *Mitoura cedrosensis*, female, undersurface, Isla de Cedros.

Genitalia: Two specimens of each sex are illustrated in Figure 8. As noted by Brown (1983) for related species, variation, as exemplified between the two specimens of each sex examined, is substantial. Comparison with illustrations in Brown (1983) gives a brief account of the related southern California taxa. The only character which may be of diagnostic value is the dorso-ventral shape of the male saccus. The female genitalia and male valvae appear to be of less taxonomic value, although quantitative differences may be evident in larger samples which could be statistically validated. Although the saccus shape may be of diagnostic value in differentiating the *loki*, *thornei*, and *nelsoni* groups, this character does not lead to any conclusions regarding reproductive isolation (Shapiro, 1978).

Type material: All Isla de Cedros, Baja California Norte, Mexico; holotype, male, Punta Norte, 28°22'N, 115°12'W, 20-22 March 1981; allotype, Punta Norte, 28°22'N, 115°12'W, 20-22 March 1982. Thirteen male and 8 female paratypes as follows: Punta Norte, 20-22 March 1981 (6 males, 5 females), 1 April 1983 (2 males, 1 female), 31 March 1983 (3 males, 1 female), 30 March 1983 (1 male), 3 July 1983 (1 male); vicinity Cerro de Cedros, 1 July 1983 (1 female).

Disposition of types. Holotype and allotype are deposited in the SDNHM. Paratypes deposited in the following institutions: Los Angeles County Museum of Natural History, Los Angeles, California; California Academy of Sciences, San Francisco, California; and Universidad Biología de Mexico, Mexico City, Mexico.

Remarks. *Mitoura cedrosensis* is closely related to *M. loki* (Skinner). It represents an insular, southernmost outpost of the California juniper-feeding *Mitoura* complex and is endemic to Isla de Cedros. The nearest known population of *M. loki* occurs approximately 300 km to the north in the vicinity of Mike's Sky Ranch in the Sierra San Pedro Martir, Baja California Norte.

M. cedrosensis is easily distinguished from *M. loki* by its smaller size¹ and by the fuscous purplish brown of the ventral hindwing surface replacing the hindwing green overscaling of *loki*. When compared to the newly described *M. thornei* Brown (1983) from southern California, *M. cedrosensis* is smaller and the markings on the hindwing are slightly darker, more fuscous, and less well-defined. The thin, white border at the outer edge of the postbasal band present in both *thornei* and *loki* is reduced or absent in *cedrosensis*. There is some question regarding the specific status of *thornei* and *cedrosensis*, both of which might be considered as subspecies of *M. loki* by some authors (Shields, 1984). *M. cedrosensis* is not similar to the unusual *M. nelsoni* (Boisduval) known from Isla Guadalupe, Baja California Norte, Mexico (Powell, 1958; Brown, 1983). The presence of basal markings representing the inner

¹Student's t-test comparing 2 sample means indicates statistically significant difference in forewing length between samples of *M. loki* and *M. cedrosensis* ($P < 0.001$).

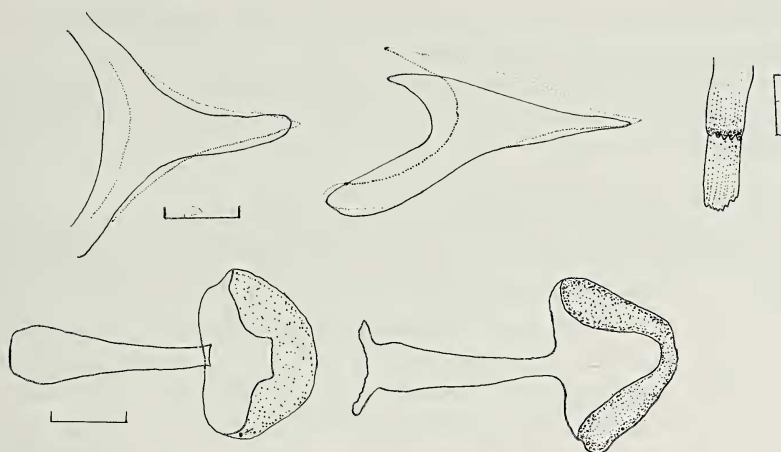


Fig. 8. Selected characters showing variation in male and female genitalia in *Mitoura cedrosensis*. **Upper Row, Left:** Dorsal view of saccus; **Right:** lateral view of valva. Saccus and valvae outlined by solid line in first specimen and dotted line in second. **Center Row:** Cornuti (both specimens identical). **Bottom Row:** Female, ductus bursa (sclerotized) and lamella antivaginalis.

margin of the postbasal band (hindwing underside) clearly separates *M. cedrosensis* from any *M. nelsoni* or *M. siva* (Edwards) populations.

Adults of *M. cedrosensis* were found in close association with California juniper (*Juniperus californica* Carr., Cupressaceae), which is undoubtedly the larval host (Brown and Faulkner, 1984). A captive female readily oviposited on the juniper, but the eggs were not viable.

California juniper, which generally exhibits a medium tall stature, grows almost prostrate in the canyons and slopes of the north end of the island. This aspect is so striking that the juniper was originally thought to be an endemic species closely related to *J. californica* (Gentry, 1950). Large stands of the juniper occur in scattered areas throughout much of the island, and it is suspected that the *Mitoura* has a distribution comparable to that of its larval host. Adults were collected in both the spring and summer probably representing 2 broods, consistent with other low elevation southern California *Mitoura* populations, i.e., *M. loki* and *M. thornei*.

11. *Strymon columella istapa* (Reakirt)

All specimens of *S. columella* taken on Cedros were collected on hilltops or prominent knolls in the area northwest of El Pueblo on the south end of the island. The larval hostplant in southern California, *Sida hederacea* (Dougl. ex Hook.) Torr. (Malvaceae), is not known from Cedros, but several other malvaceous plants are present. Although currently referred to *S. columella istapa*, specimens from Baja California and adjacent southern California are undoubtedly subspecifically

distinct from mainland *istapa* (Clench, *in litt.*). Insular and peninsular specimens are indistinguishable.

Specimens examined: vicinity El Pueblo, 29 March 1983 (1 male), 3 April 1983 (1 male); vicinity Cerro de Cedros, 1 July 1983 (5 males, 1 female).

12. *Strymon melinus pudica* (Hy. Edwards)

S. melinus is probably the most widespread Nearctic hairstreak. It occurs throughout much of the United States, extending into northern Mexico, and occupies a tremendous variety of habitats from mountains to deserts. *S. melinus* was first reported from Cedros by Rindge (1948), and it was encountered commonly in both spring and summer of 1983. This insect is a frequent hilltopper and was collected on both ends of the island. A number of potential larval hosts are available including *Malva*, *Phaseolus*, and *Eriogonum*. Larvae were abundant on the flower heads of the endemic *Eriogonum molle* Greene (Polygonaceae) in the summer of 1983. All Baja California material is best referred to subspecies *pudica*.

Specimens examined: vicinity Punta Norte, 28 February 1941 (1 male *leg.*: J. Garth, 30 March 1983 (2 males, 1 female) 31 March 1983 (1 male), 1 April 1983 (3 males), 3 July 1983 (1 female), ex-larva, emerged 25 July 1983 (1 female), ex-larva, emerged 31 July 1983 (1 male); vicinity El Pueblo, 29 March 1983 (10 males), 3 April 1983 (2 males, 1 female), 4 April 1983 (2 males); vicinity Cerro de Cedros, 1 July 1983 (2 males, 6 females); Gran Cañon, 2 July 1983 (2 males); Punta Prieta, 5 July 1983 (2 males).

13. *Brephidium exilis* (Boisduval)

B. exilis occurs throughout Baja California, ranging from the coasts to the deserts and from Tijuana to La Paz. On Cedros it was most commonly encountered in heavily disturbed areas where weedy *Atriplex* and *Chenopodium* (Chenopodiaceae) formed dense clumps. Two such habitats include the vicinity of the fishing village at Punta Norte, and near El Pueblo at the south end of the island. Specimens from Cedros are indistinguishable from those collected elsewhere on the peninsula. *B. exilis* is also known from all the California Channel Islands (Miller, 1984).

Specimens examined: vicinity Punta Norte, 25 February 1932 (1 male), 28 February 1941 (1 female), both *leg.*: J. Garth; Punta Norte 20-22 March 1981 (1 male, 1 female), 30 March 1983 (1 male, 1 female), 1 April 1983 (2 males, 1 female), 2 April 1983 (1 female); vicinity El Pueblo, 29 March (1 male, 1 female), 4 April 1983 (3 males), 13 July 1983 (1 female); Morro Redondo, 5 April 1983 (1 male); Cerro de Cedros, 1 July 1983 (1 male); Gran Cañon, 2 July 1983 (2 males, 1 female).

14. *Leptotes marina* (Reakirt)

L. marina was first reported from Cedros by Rindge (1948). Although not collected by us in the spring, *L. marina* was quite common in the

summer of 1983. This species occurs on both the north and south ends of the island, particularly in the lowlands and in disturbed areas. *L. marina* ranges the length of Baja California, extending north into California; it has also been collected on Santa Catalina, Santa Cruz, and Anacapa Islands (Emmel and Emmel, 1973; Langston, 1980; Miller, 1984).

Specimens examined: vicinity Punta Norte, 25 February 1932 (1 male), leg: J. Garth, 3 July 1983 (2 males, 1 female); vicinity Cerro de Cedros, 1 July 1983 (2 males, 1 female).

15. *Hemiargus ceraunus gyas* (Edwards)

Although quite rare and localized in the spring, *H. ceraunus* was abundant and widespread in the summer of 1983. This species was collected almost everywhere on the island, although most commonly at low elevations.

H. ceraunus gyas is distributed the length of Baja California and in a variety of habitats. It is multiple brooded and several genera of Fabaceae, including *Astragalus*, which is available on Cedros, are utilized as larval hosts.

Specimens examined: vicinity Punta Norte, 25 February 1932 (1 female), leg: J. Garth, 3 July 1983 (5 males, 1 female); Punta Morro Redondo, 5 April 1983 (5 females); vicinity Cerro de Cedros, 1 July 1983 (16 males, 6 females); Gran Cañon, 2 July 1983 (2 males, 1 female); Punta Prieta, 5 July 1983 (6 males); El Pueblo, 13 July 1983 (1 male).

16. *Philotes sonorensis* (Felder and Felder)

Restricted to California and adjacent Baja California, *P. sonorensis* reaches its southernmost limit on Isla de Cedros, slightly disjunct from the nearest peninsular population. First collected on Cedros by J. Garth in 1941, *P. sonorensis* was quite common in the canyons of the north end of the island in the spring of 1983. Typically one of the earliest spring fliers in coastal areas peaking in February and March, our captures in late March and April seem unusually late; the July record is extraordinary. Several species of *Dudleya* (Crassulaceae) are available as larval hosts; a single larva was observed feeding on *Dudleya pachyphytum* (Moran and Benedict, 1981).

Specimens examined: vicinity Punta Norte, 28 February 1941 (1 male), leg: J. Garth, 20-22 March 1981 (3 males, 1 female), 30 March 1983 (4 males), 31 March 1983 (7 males), 1 April 1983 (8 males), 3 July 1983 (1 female).

17. *Euphilotes battoides garthi* Mattoni

Rindge (1948) first reported *E. battoides* from Cedros; he also recognized that this insular population was phenotypically distinct. Shields (1975) later referred to two males from Cedros as conforming to his description of *E. battoides allyni*. Mattoni (1988) recently described the Cedros population as *garthi*, and examined its relationships within the *bernardino* cluster of subspecies.

E. battoides garthi is endemic to Isla de Cedros and probably occurs throughout the island wherever *Eriogonum fasciculatum* (Benth.) (Polygonaceae) is found. We encountered it most frequently in the canyons and washes of the north end of the island in spring 1983. *E. battoides garthi* represents the southernmost subspecies of the *E. battoides* complex. The nearest *battoides* population occurs about 130 km northeast in the northern central desert region of the peninsula (Brown and Faulkner, 1984).

Specimens examined: canyons west of Punta Norte, 30 March 1983 (2 males), 1 April 1983 (5 males, 4 females), 2 April 1983 (1 male), 1 July 1983 (1 male, 1 female), 3 July 1983 (2 females); Cedros Island, no further locality data, 15 March 1939 (3 males), no *leg* data, LACM, 18 March 1939 (1 female), no *lge* data, CAS.

18. *Celastrina ladon echo* (Edwards)

C. ladon echo, the westernmost subspecies of the widespread Nearctic *ladon* complex, has an extensive range from British Columbia to Baja California (Langston, 1975). It is also known from several islands off the western coast of California (Emmel and Emmel, 1973; Langston, 1979; Miller, 1984). The population on Cedros represents an isolated and disjunct outpost. The echo blue was the most common lycaenid encountered on Cedros; in the spring of 1983 it was particularly abundant in the canyons and washes of the north end of the island; and in July 1983, it was most common in the vicinity of Cerro de Cedros. The abundance of freshly emerged adults in both spring and summer indicates that the species is at least double brooded on Cedros. Larval hostplants encompass several families and many genera including *Rhus* and *Lotus*, both available on Cedros.

Specimens examined: vicinity Punta Norte, 25 February 1932 (2 males, 2 females), 28 February 1941 (21 males, 3 females), *leg*: J. Garth, 20-22 March 1981 (1 female), 30 March 1983 (6 males, 2 females), 31 March 1983 (6 males, 1 female), 1 April 1983 (2 males, 2 females), 2 April 1983 (4 males), 3 July 1983 (2 males, 2 females); vicinity Cerro de Cedros, 1 July 1983 (3 males); Gran Cañon, 2 July 1983 (1 male, 2 females).

RIODINIDAE

19. *Apodemia mormo virgulti* Behr

Figures 9 and 10

A dark segregate of *Apodemia mormo virgulti* with greatly reduced hindwing orange occurs in central and north central Baja California. Opler and Powell (1961) have indicated that these dark populations may warrant subspecific recognition. Specimens from Cedros are consistent in maculation and color, and represent the extreme in this phenotype.



Fig. 9. *Apodemia mormo virgulti*, female, uppersurface, Isla de Cedros.

Fig. 10. *Apodemia mormo virgulti*, female, undersurface, Isla de Cedros.

Apodemia mormo occurs in the canyons and washes of the north end of the island, generally associated with *Eriogonum fasciculatum* (Benth.) (Polygonaceae). It is known from the south end but is much less common there. The presence of *A. mormo* adults from March through July appears to illustrate the extended flight periods of coastal species previously suggested by Langston (1975). Although *A. mormo* extends all the way to the cape region of the peninsula, in the form of *Apodemia mormo maxima* (Weeks), Isla de Cedros is near the southernmost distribution of the *virgulti*-like phenotype.

Specimens examined: Punta Norte, 20-22 March 1981 (15 males, 5 females), 30 March 1983 (2 males), 31 March 1983 (2 females), 1 April 1983 (1 male, 1 female), 2 April 1983 (1 female), 3 July 1983 (1 male, 3 females); vicinity Cerro de Cedros, 1 July 1983 (1 male, 1 female).

20. *Calephelis wrighti* Holland

C. wrighti occurs throughout Baja California. First collected on Cedros by Hanna and Slevin in 1922, *C. wrighti* was one of the more common butterflies that we encountered in 1983. It was collected on both the north and south ends of the island, commonly in association with *Bebbia juncea* (Benth.) Green (Asteraceae), the larval host.

Considerable confusion exists in older literature between *C. wrighti* and *C. nemesi* (Edwards). Rindge's (1948) records of *Calephelis nemesi australis* (Edwards) from Cedros are almost certainly misdetermined specimens of *C. wrighti*.

Specimens examined: Cedros Island, 22 July 1922 (1 male, 1 female), *le*: Hanna and Slevin, CAS; El Pueblo, 29 March 1983 (1 male, 1 female), El Pueblo, 3 April 1983 (2 males, 1 female), 4 April 1983 (3 males, 4 females); Punta Norte, 30 March 1983 (2 males), 31 March 1983 (2 females), 2 April 1983 (1 male); Gran Cañon, 2 July 1983 (2 males); Punta Prieta, 5 July 1983 (1 male, 1 female).

NYMPHALIDAE

21. *Vanessa cardui* (Linneus)

In the spring of 1983 *V. cardui* was abundant throughout southern California and northern Baja California, exhibiting one of its periodic unidirectional migrations. The butterfly was extremely common on Cedros, with both flight-worn and freshly emerged adults evident. Larvae were plentiful on both the weedy *Malva parviflora* L. (Malvaceae) and *Lupinus sparsiflorus* Benth. (Fabaceae). In years of exceptional abundance such as 1983, an extremely wide variety of larval hostplants are exploited by *V. cardui* (Emmel and Emmel, 1973).

First reported from Cedros by Rindge (1948), *V. cardui* is commonly encountered throughout the peninsula of Baja California.

Specimens examined: vicinity Punta Norte, 28 February 1941 (4 males, 2 females), leg: J. Garth; El Pueblo, 29 March 1983 (1 male, 2 females), 4 April 1983 (1 male), ex-larvae, ex-*Lupinus*, (4 females) emerged as follows: 20 April 1983, 19 April 1983, 18 April 1983, and 16 April 1983; Punta Norte, 30 March 1983 (4 males, 6 females), 31 March 1983 (1 male, 1 female), 1 April (1 female), 2 April 1983 (1 male, 1 female); vicinity Cerro de Cedros, 3 April 1983 (1 female).

22. *Vanessa annabella* (Field)

Another of the widespread vanessas, *annabella*, was encountered in large numbers on Cedros in the spring of 1983. It was particularly common at low elevations and in disturbed areas. *V. annabella* occurs the length of the peninsula of Baja California; insular and peninsular specimens are indistinguishable. *Vanessa virginiensis* (Drury), a notorious pioneer species present in many insular situations, was absent from Cedros; its hostplant, *Gnaphalium*, is known from the island.

Specimens examined: Punta Norte, 30 March 1983 (1 female), 31 March 1983 (1 male, 1 female), 1 April 1983 (1 female), 2 April 1983 (2 females); El Pueblo, 29 March 1983 (2 males, 2 females), 4 April 1983 (2 males, 1 female); vicinity Cerro de Cedros, 1 July 1983 (1 male).

DANAIDAE

23. *Danaus gilippus strigosus* (Bates)

A common inhabitant of the desert regions of southern California and Arizona, the striated queen occurs the length of the peninsula of Baja California, and in a variety of habitats. Although rather uncommon in the spring, with 1 or 2 individuals observed each day, *D. gilippus* was quite common in the summer of 1983 on both ends of the island. This species was reported from Cedros by Rindge (1948); his record is from the fall when the butterfly is probably more common. The only potential larval host available on Cedros is *Asclepias subulata* Decne. (Asclepiadaceae). Specimens of *D. gilippus* collected on the island may represent breeding residents as well as strays from the mainland.

Specimens examined: Punta Norte, 1 April 1983 (2 males) vicinity El Pueblo, 4 April 1983 (1 male); vicinity Cerro de Cedros, 1 July 1983 (1 female).

Discussion and Summary

Isla de Cedros supports an exceedingly depauperate butterfly fauna, primarily as a consequence of a limited mainland species pool. The Viscaïno-Magdalena region of the peninsula directly adjacent to Cedros, lies near the southern end of the Californian Province influence, and considerably beyond the northern extremity of the Cape Province influence.

The biotic diversity of the Californian Province attenuates north of Isla de Cedros, with strays rarely occurring as far south as 28°N. Seasonal meteorological patterns do not favor immigration from this direction. Californian elements present on Cedros presumably represent relict populations separated from their contiguously distributed mainland populations since the Pleistocene.

Most of the Neotropical species inhabiting the Cape Region scarcely extend northward into the Viscaïno Desert. Even such well known dispersers as *Phoebis agarithe* and *Ascia monuste* are yet to be recorded from Cedros. Apparently the combination of the Viscaïno Desert and the Pacific Ocean together present an almost impenetrable barrier to Cape Province species' immigration to the island. The lack of suitable larval hostplants would also act to preclude these species from establishing in the event they were to be introduced to the island. Elements of Neotropical affinity present on Cedros represent widespread species occurring from Central America northward to at least southern California.

A speculative explanation for the conspicuous absence of butterflies common to the Californian province, such as *Icaricia acmon*, *Everes amyntula*, *Callophrys dumetorum*, and representatives of the genus *Satyrium*, can be extracted from the equilibrium theory of island biogeography. Since most of the above species occur sympatrically in cismontane Baja California with many of the island's resident species, it is possible that several of these missing butterflies were formerly resident on the island. Their absence may be partially explained by the reduction in floral and faunal diversity of the island which occurred as a result of its over-saturated biota following its separation from the Baja California peninsula. Many of the expected but absent species may have gone extinct on Cedros, and because prevailing conditions did not favour southward dispersal, were never reintroduced.

According to Pielou (1979), a low species diversity exists on islands not only as a function of land area and distance from the mainland, but also with aspects of community complexity acting to maintain this status. The fragmentary or patchy occurrence of suitable larval host-

plants makes it difficult for immigrant species of moderate host specificity to become established. The effects of patchy habitats in insular situations are discussed by Powell (1981) regarding the introduction of insect species onto Santa Cruz Island, California.

It should also be noted that man's presence on and his introduction of herbivores to Isla de Cedros has had little impact on the island's native flora and fauna. Man's activities have been restricted to the southeastern end of the island and in a lesser degree to the areas in and around the fishing village and abandoned copper mine on the northeast end. There is no current effort at agriculture, and its inherent ecological impact, owing to the poor soil conditions and undependable rainfall. There is barely enough groundwater from springs to provide for the growing needs of the village population, with none available for irrigation. Feral grazing animals, especially goats and pigs, are restricted to the southeast end of the island and have overall resulted in only minor impact on the island's native vegetation. This point is in sharp contrast to the effect that uncontrolled feral animals, mainly goats, have had on the flora of other Coastal Pacific islands, such as Santa Catalina Island (Coblentz, 1980) and San Clemente Island (Faulkner, personal observation) in California, and Isla Guadalupe (Moran and Lindsey, 1950) in Baja California, Mexico.

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Addenda. *Colias cesonia* Stoll has been documented recently from Isla de Cedros, bringing the species total to 24. The single record probably represents a stray from the peninsula rather than an indigenous population.